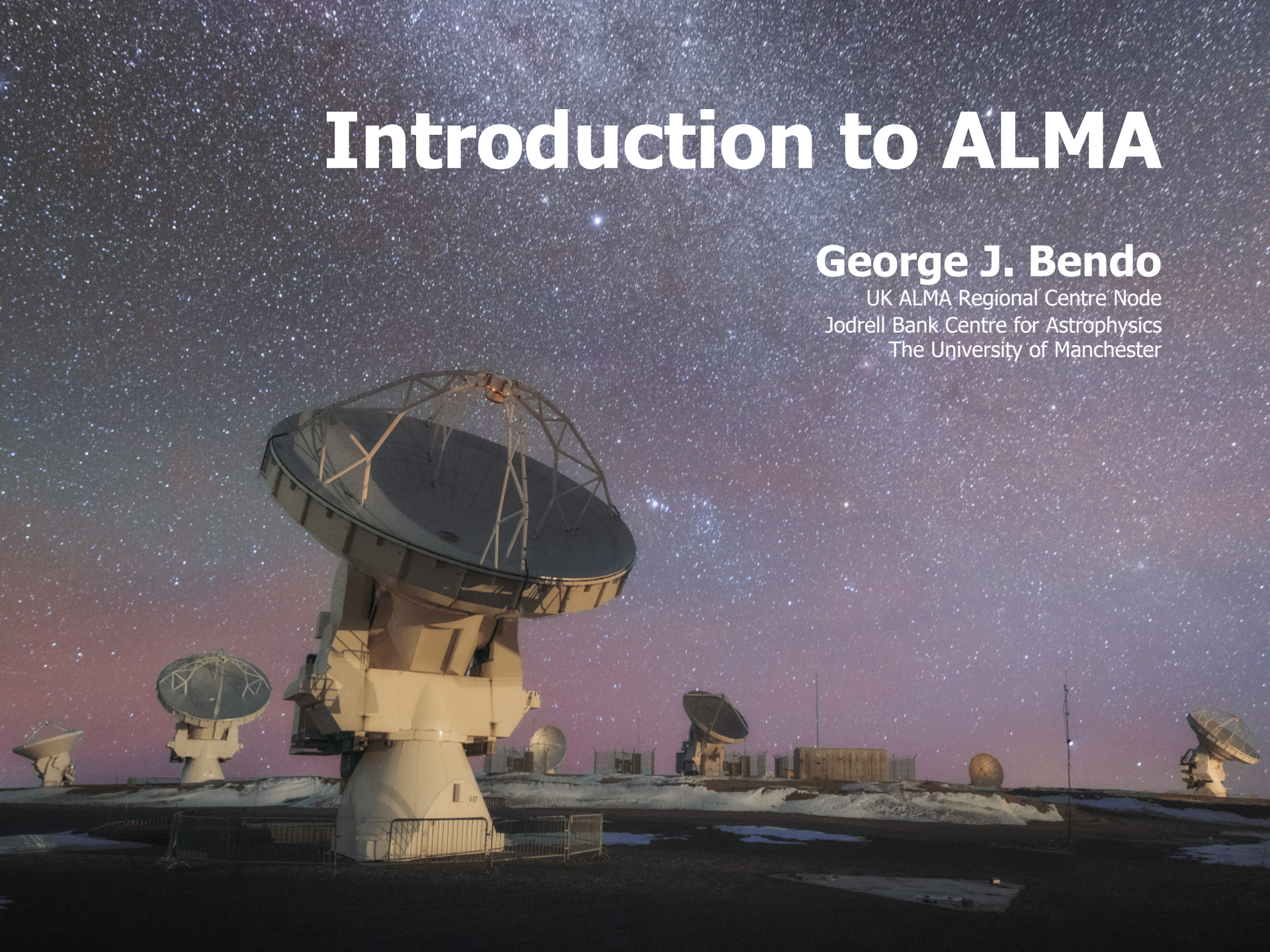
Introduction to ALMA



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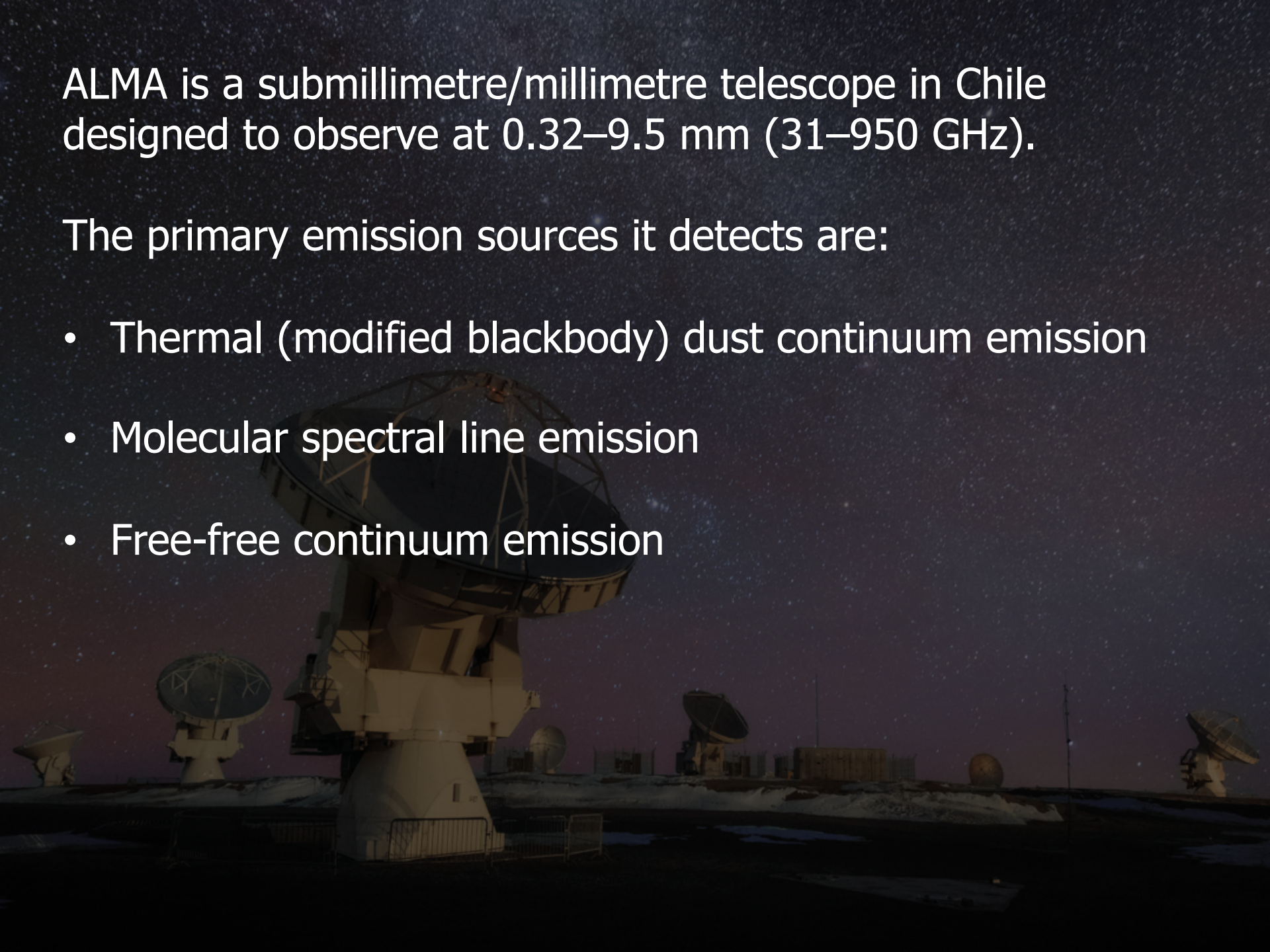


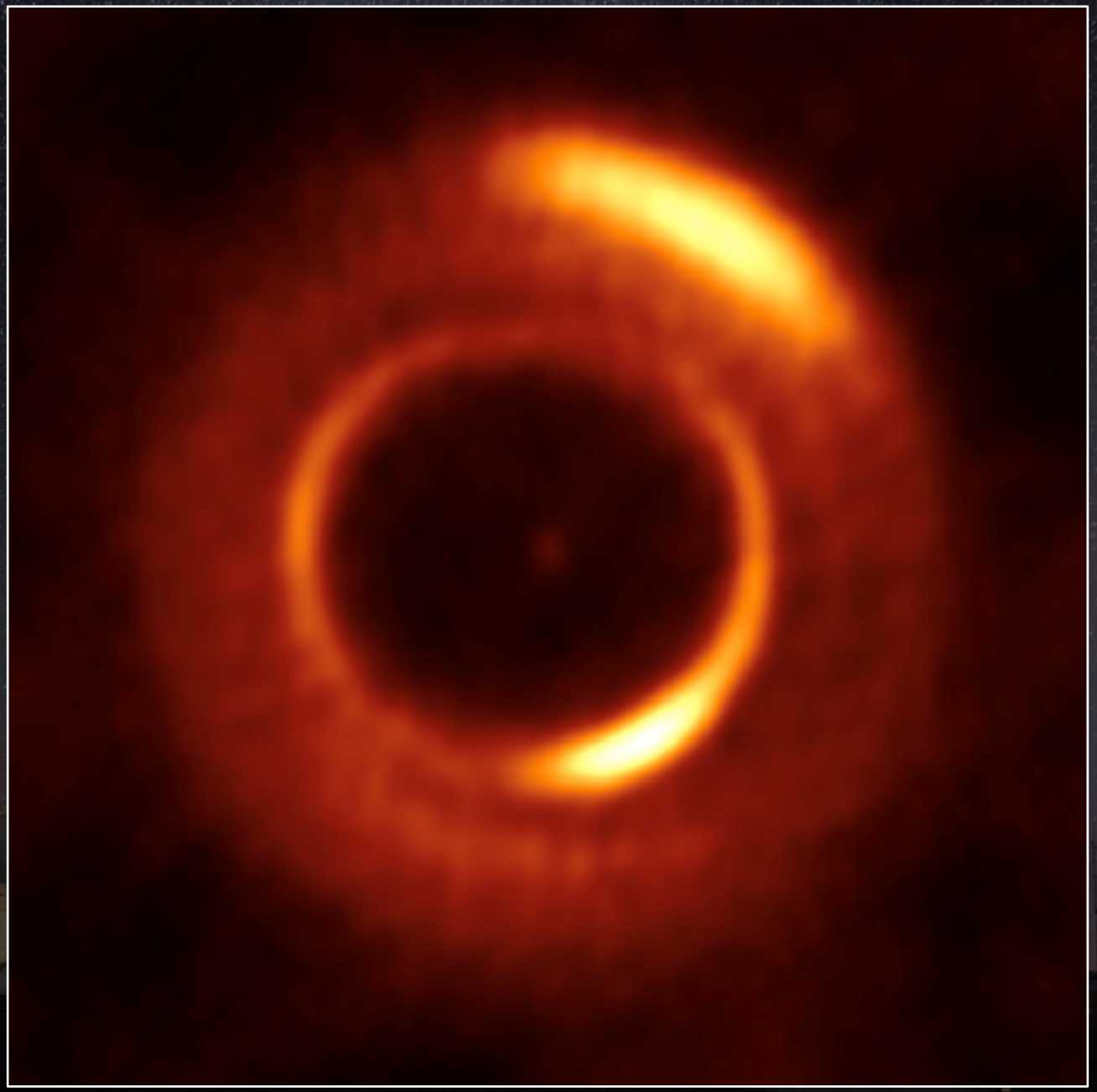
ALMA is a submillimetre/millimetre telescope in Chile designed to observe at 0.32–9.5 mm (31–950 GHz).

The primary emission sources it detects are:

- Thermal (modified blackbody) dust continuum emission
- Molecular spectral line emission
- Free-free continuum emission

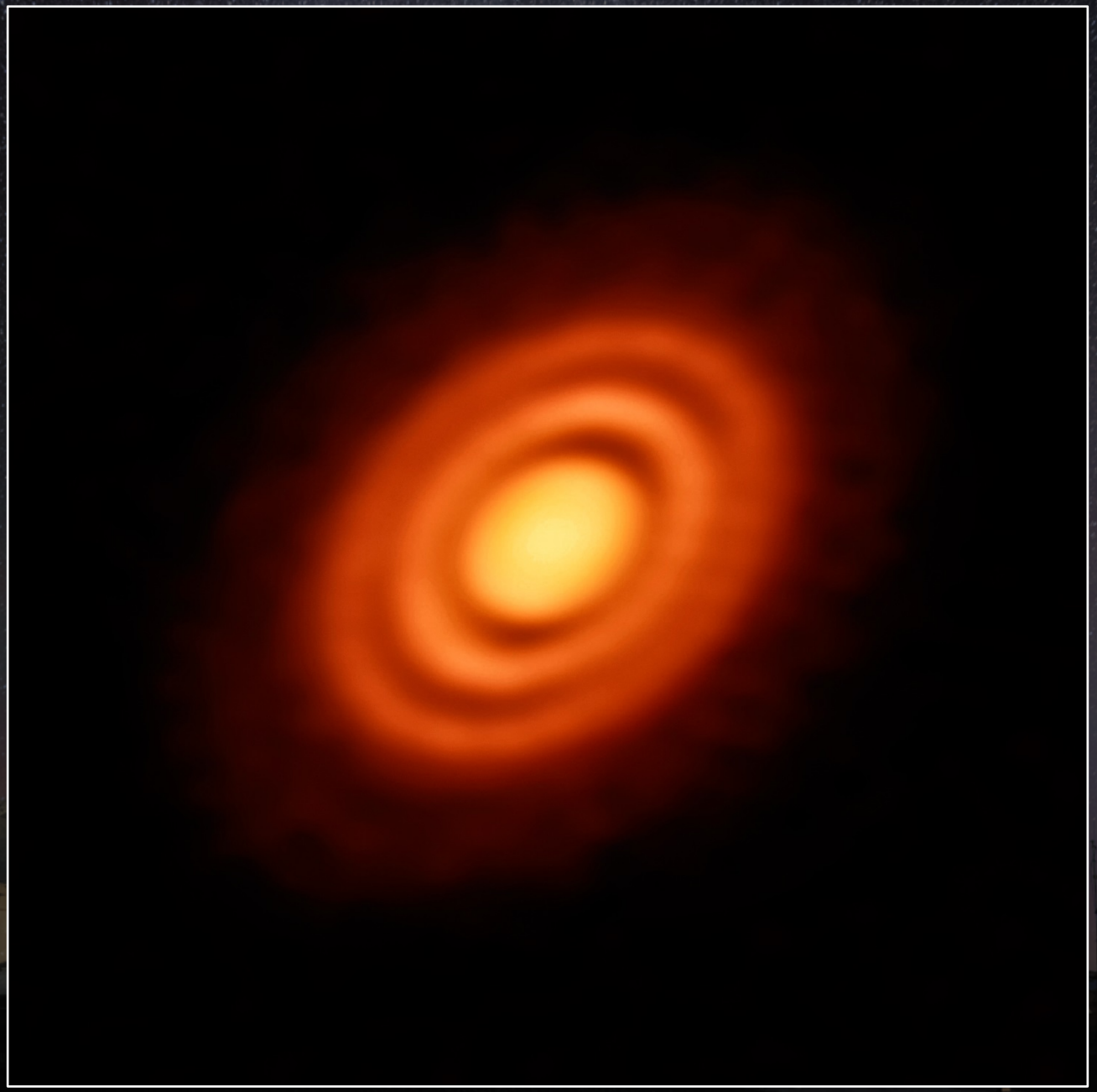
ALMA science goals

- Study objects in the solar system at millimetre wavelengths.
- Image the gas and dust in dense molecular clouds and protostellar discs.
- Observe the formation of dust and molecules around evolved stellar objects.
- Map dust and molecular gas in nearby galaxies.
- Detect dust and spectral line emission from high-redshift galaxies.



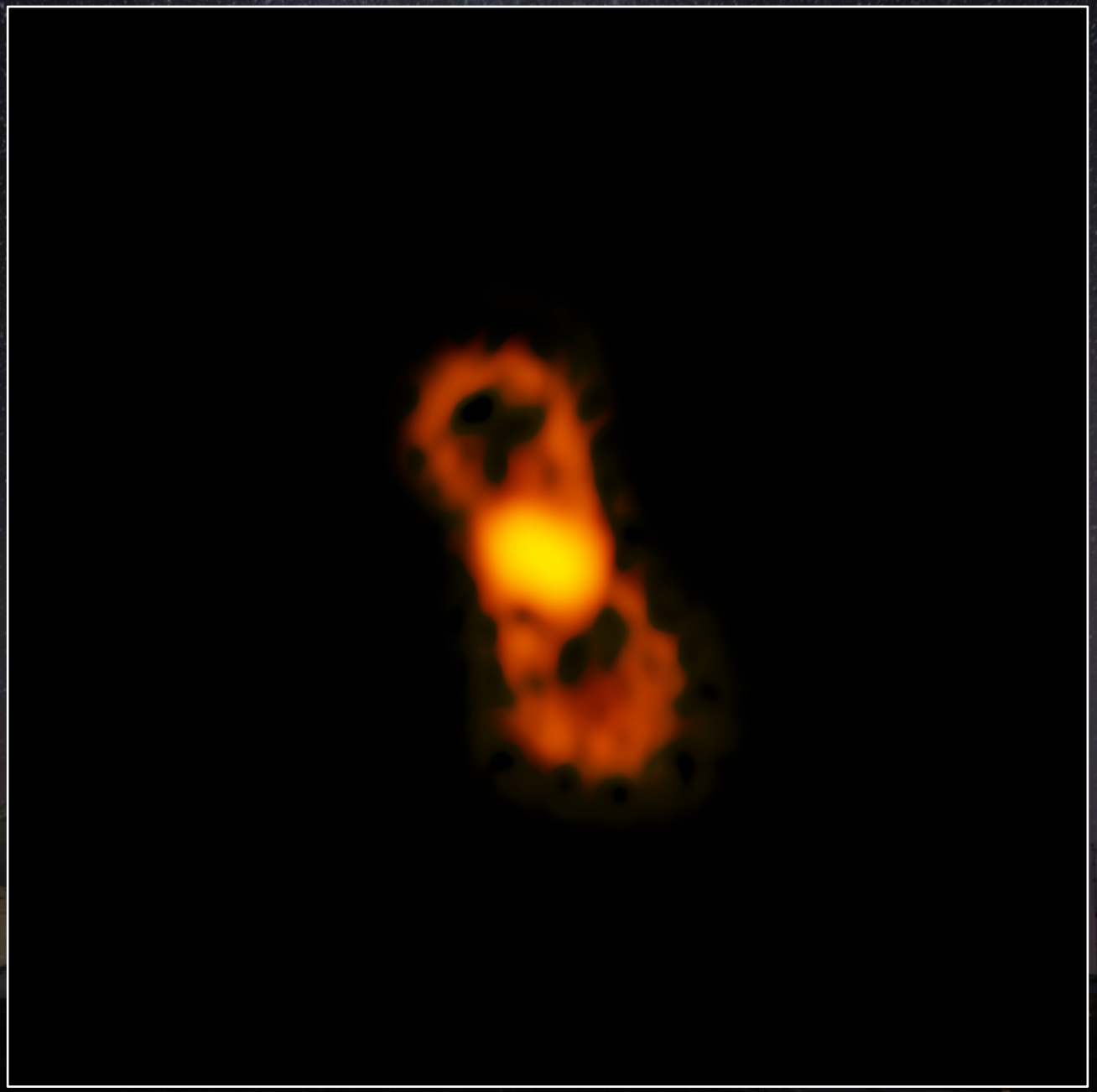
MWC 758

Credit: ALMA (ESO/NAOJ/NRAO)/Dong et al.



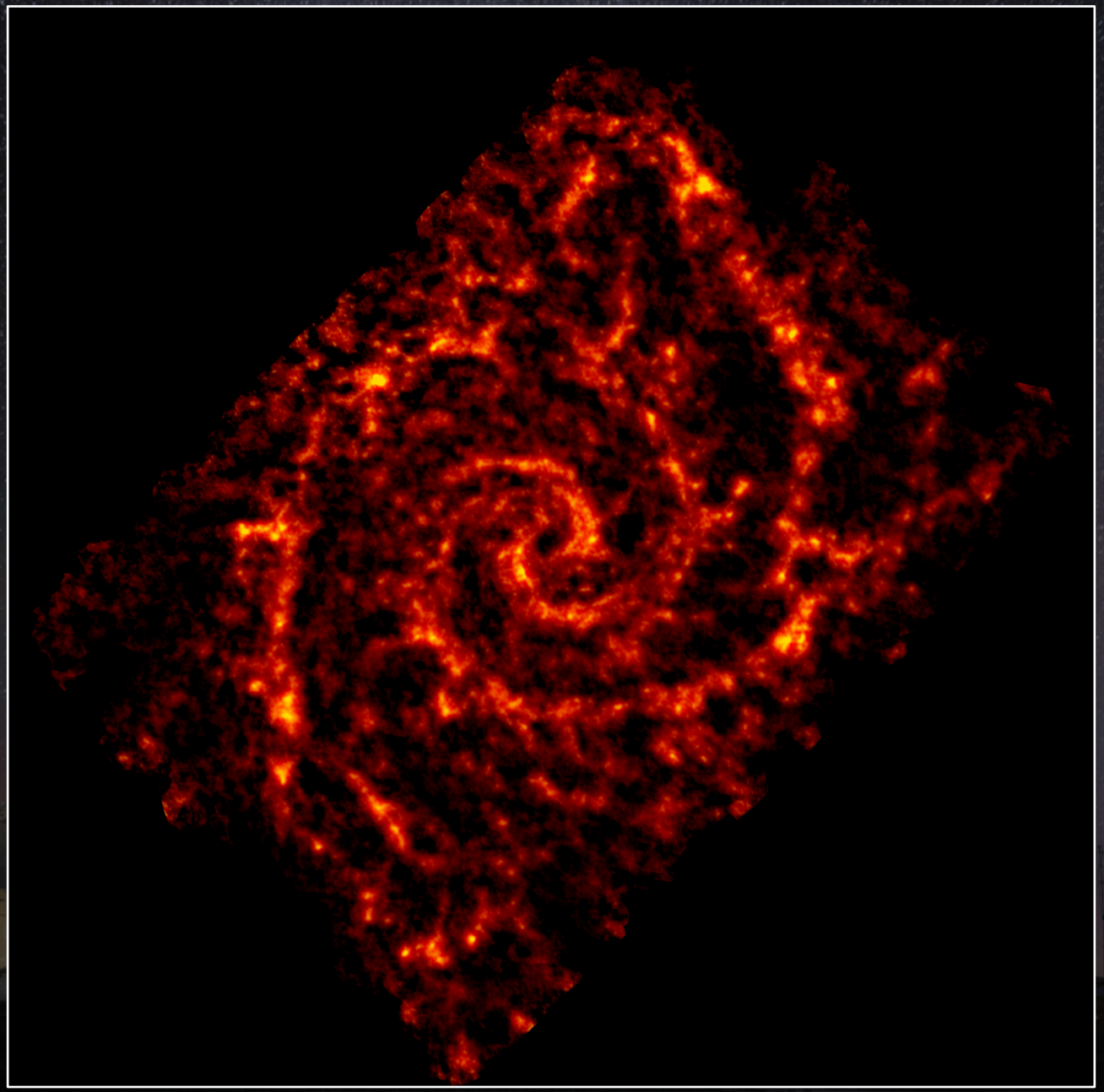
HD 163296

Credit: ESO, ALMA (ESO/NAOJ/NRAO); A. Isella; B. Saxton (NRAO/AUI/NSF)



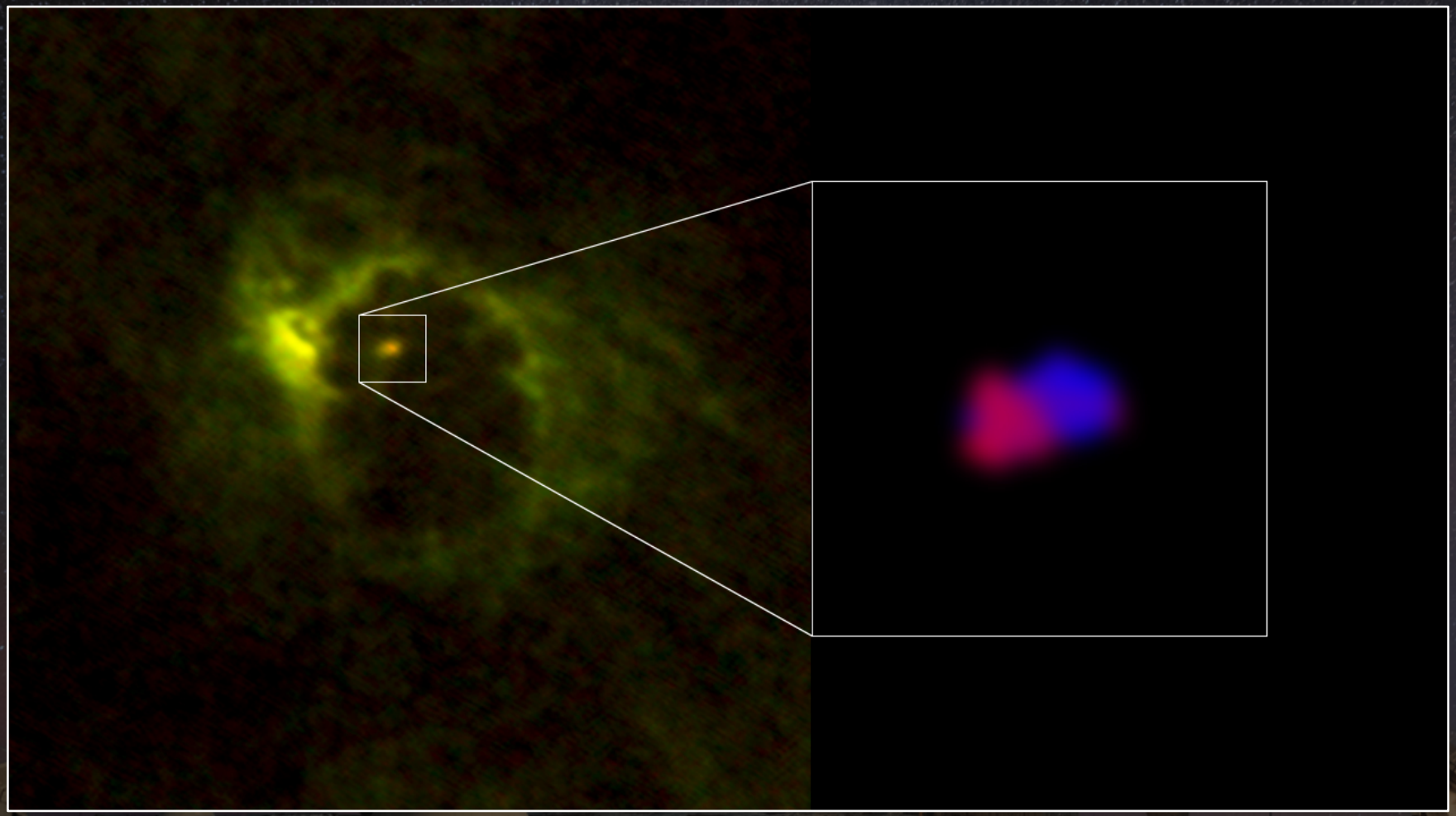
CK Vul

Credit: ALMA (ESO/NAOJ/NRAO); NRAO/AUI/NSF; B. Saxton



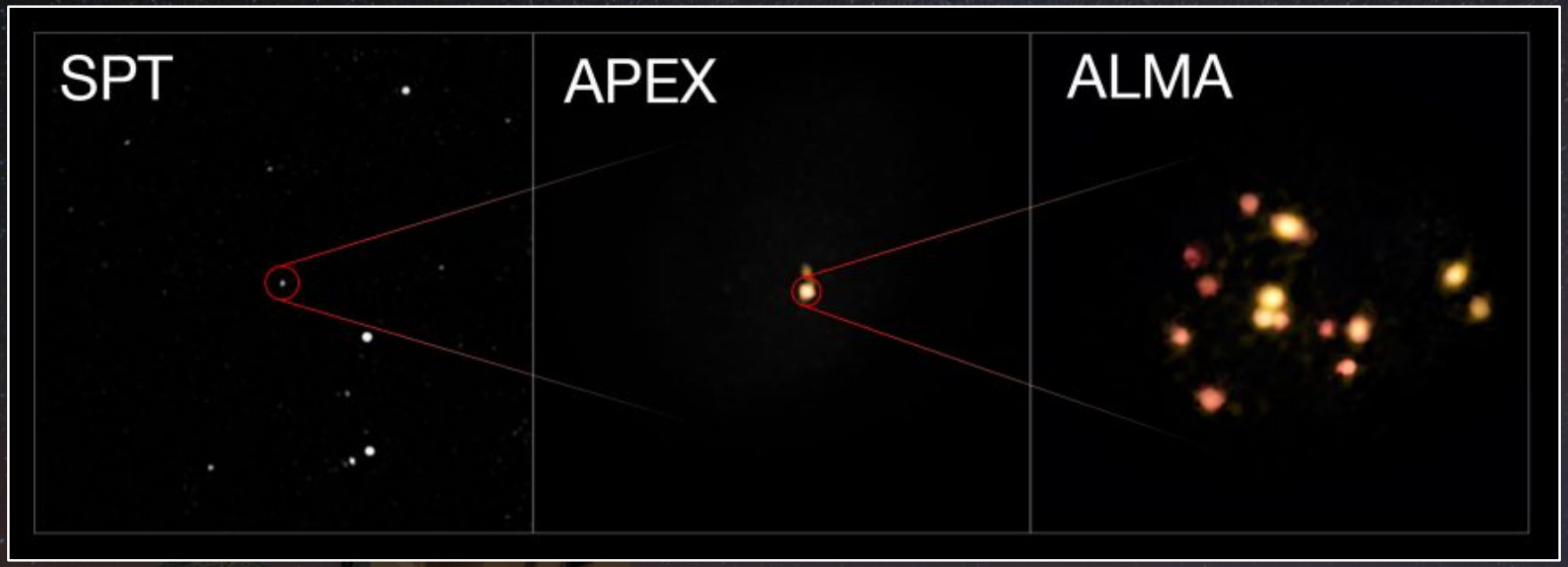
M74

Credit: ALMA (ESO/NAOJ/NRAO); NRAO/AUI/NSF, B. Saxton



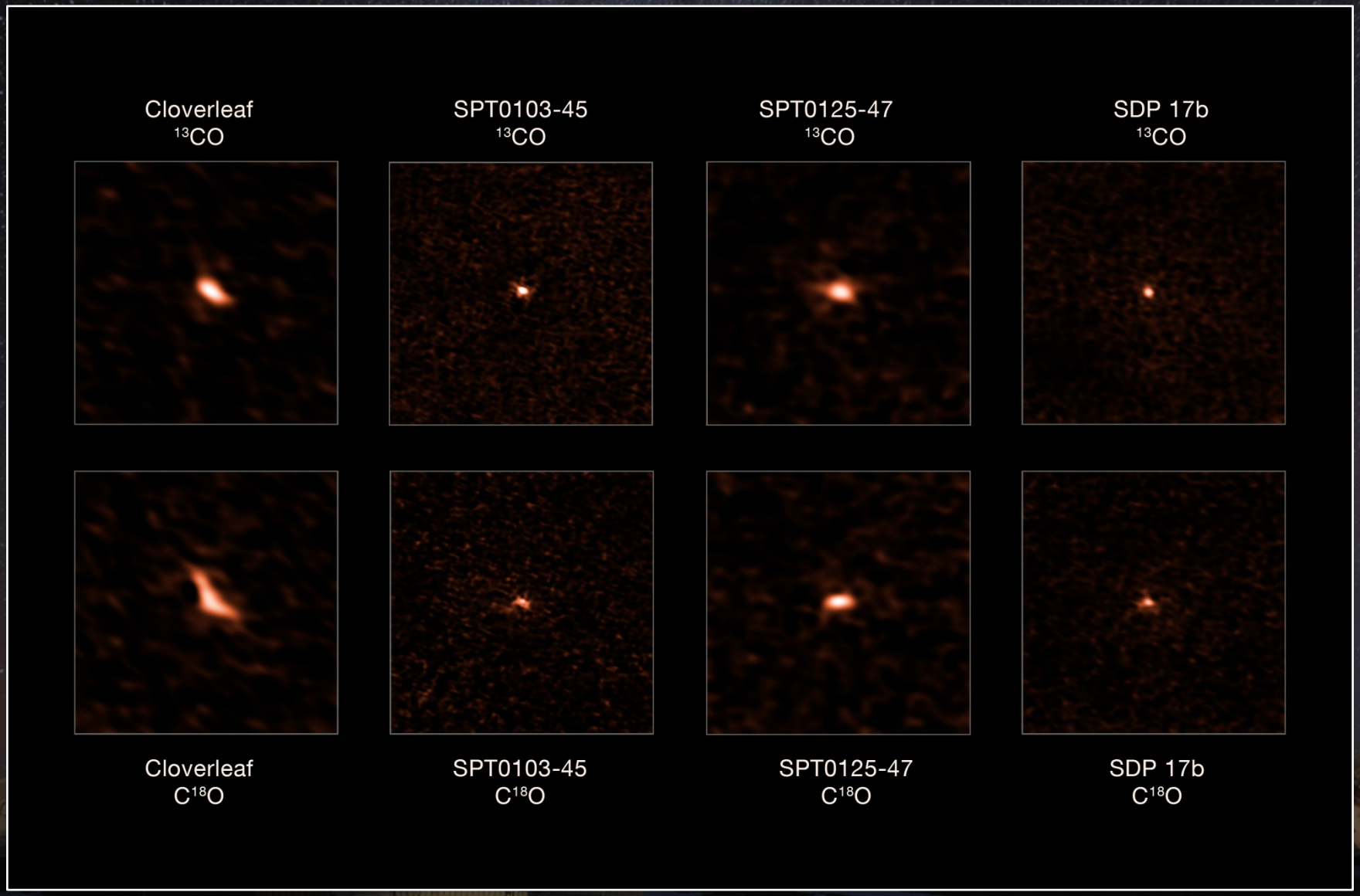
NGC 1068

Credit: ALMA (ESO/NAOJ/NRAO), Imanishi et al.



SPT2349-56

Credit: ESO/ALMA (ESO/NAOJ/NRAO)/Miller et al.



Multiple high-redshift starbursts

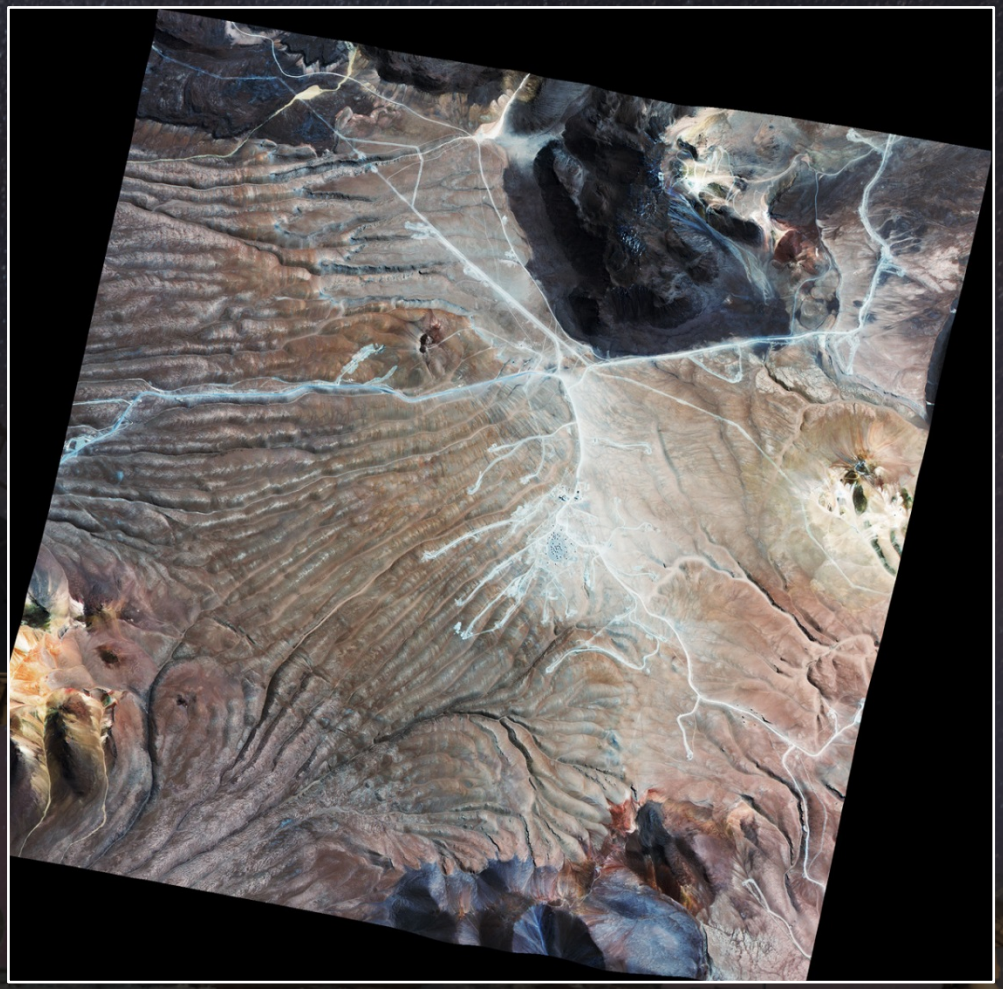
Credit: ESO/Zhang et al.; ALMA (ESO/NAOJ/NRAO)

Gamma ray burst

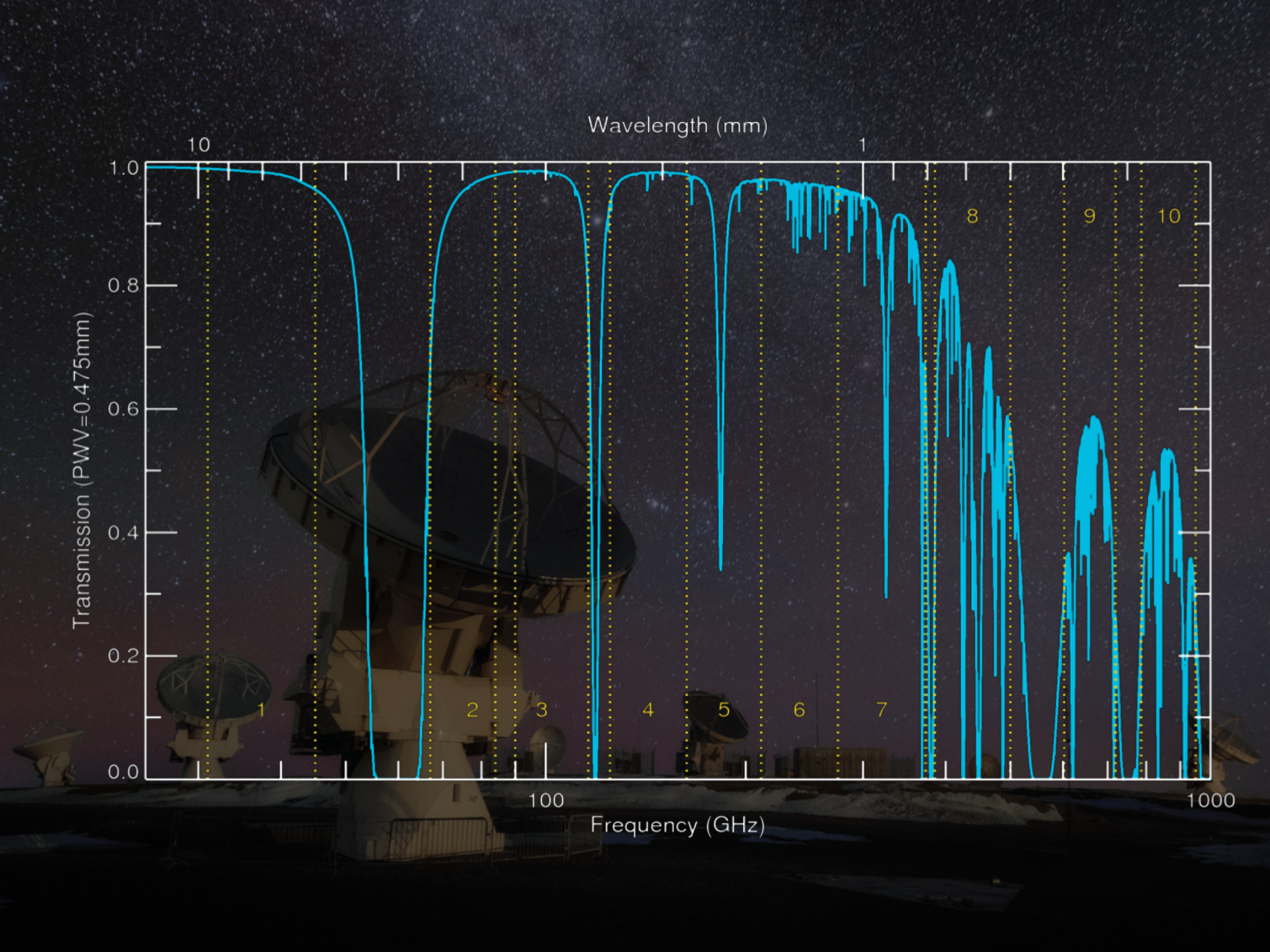
Credit: ALMA (ESO/NAOJ/NRAO), T. Laskar; NRAO/AUI/NSF, B. Saxton

ALMA is located in the Atacama Desert, a high-altitude desert in Chile.

Because the air is cold and dry, the site is ideal for observing in submillimetre and millimetre bands.



(Credit: Aerophotogrammetry Sevice, Chilean Air Force)


Wavelength (mm)
10
1
1.0
0.8
0.6
0.4
0.2
0.0
Transmission (PWV=0.475mm)
1
2
3
4
5
6
7
8
9
10
100
1000
Frequency (GHz)

Band	Frequency (GHz)	Wavelength (mm)	Primary Beam (arcsec)	Angular Resolution (arcsec)	
				Compact Configuration	Extended Configuration
3	84-116	2.6-3.6	63	3.4	0.042
4	125-163	1.8-2.4	43	2.3	0.028
5	163-211	1.4-1.9	30	1.8	0.023
6	211-275	1.1-1.4	25	1.5	0.018
7	275-373	0.80-1.09	19	1.0	0.028
8	385-500	0.60-0.78	14	0.74	0.046
9	602-720	0.42-0.50	9.2	0.52	0.033
10	787-950	0.32-0.38	7.1	0.39	0.024

ALMA has three subarrays that observe different-sized structures:

- The main array (50 antennas with 12m diameters)
- The Atacama Compact Array (12 antennas with 7m diameters)
- The total power antennas (4 antennas with 12m diameters)

(Credit: ESO)

The main (12m) array can be reconfigured in different ways to achieve different angular resolutions.

- Short baseline configurations image extended emission.
- Long baseline configurations resolve small structures.

(Credit: ESO)

The ACA is used to image large-scale structures that are usually resolved out by the 12m array. It can also be used as a stand-alone array when detecting resolved structure is unimportant.

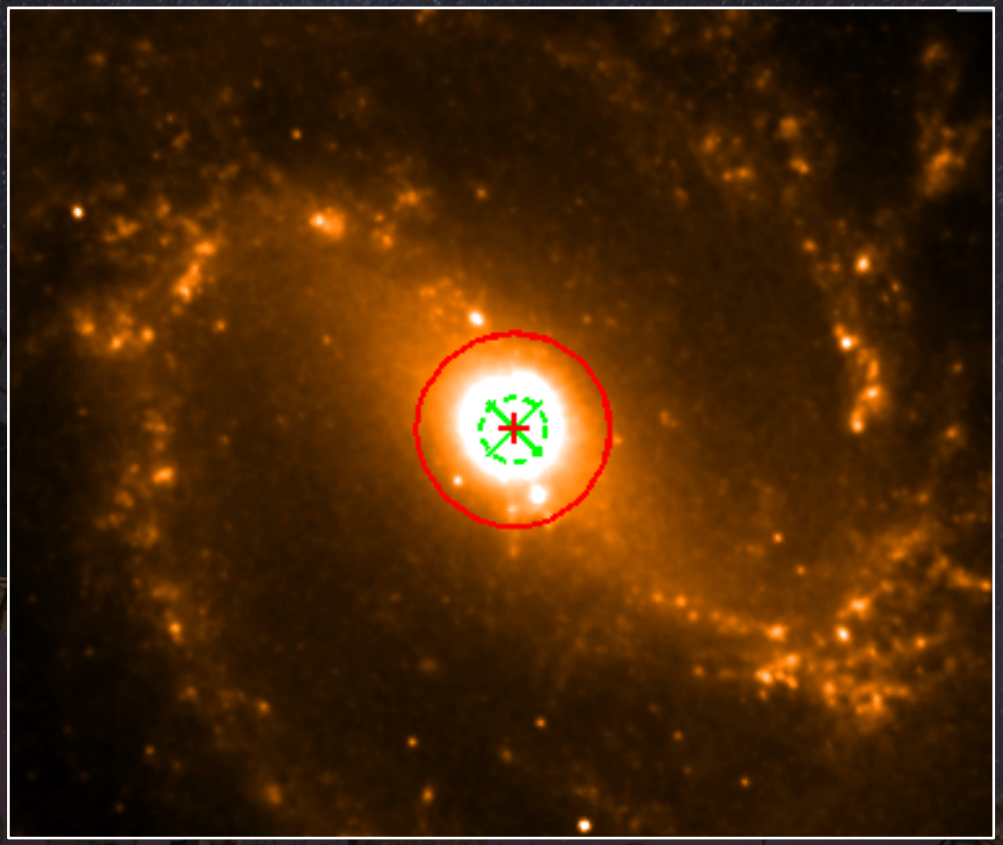
(Credit: ESO)

The total power antennas are used to detect large-scale line emission resolved out by both the 12m and ACA arrays. (Continuum-imaging capabilities may be added in the future.)

(Credit: ESO)

The most basic field that can be imaged by ALMA is a single pointing.

However, ALMA can also image multiple pointings within the same Science Goal or mosaic a rectangular field.



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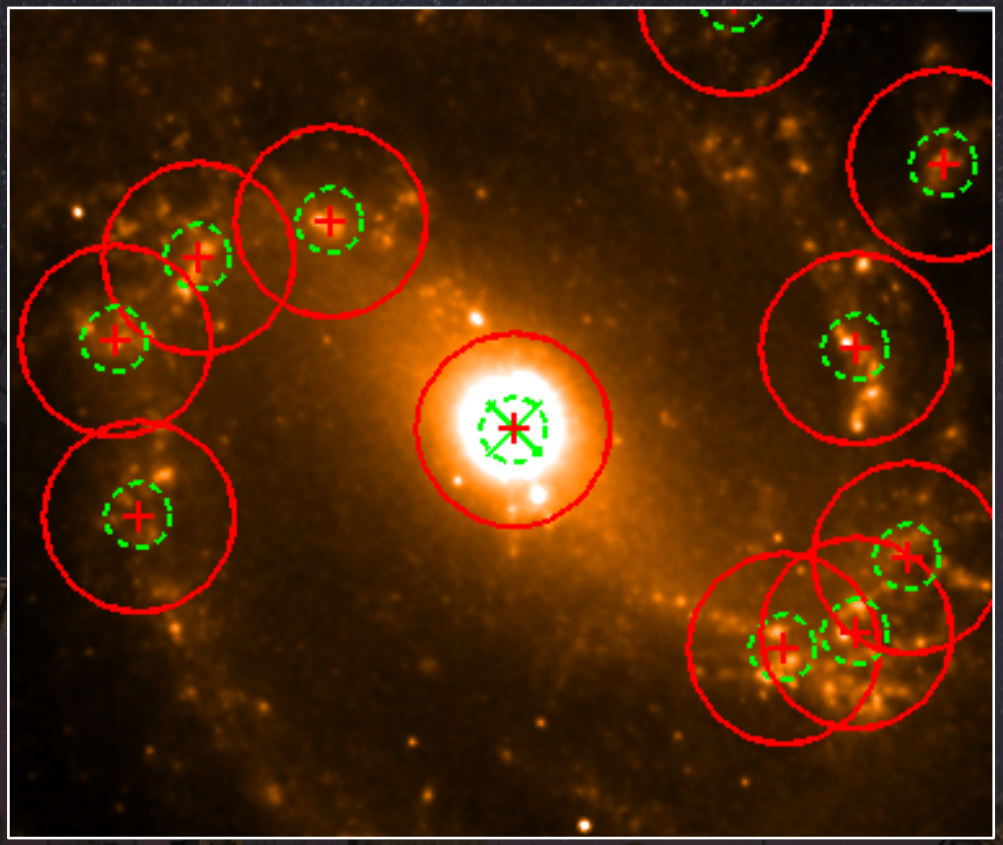

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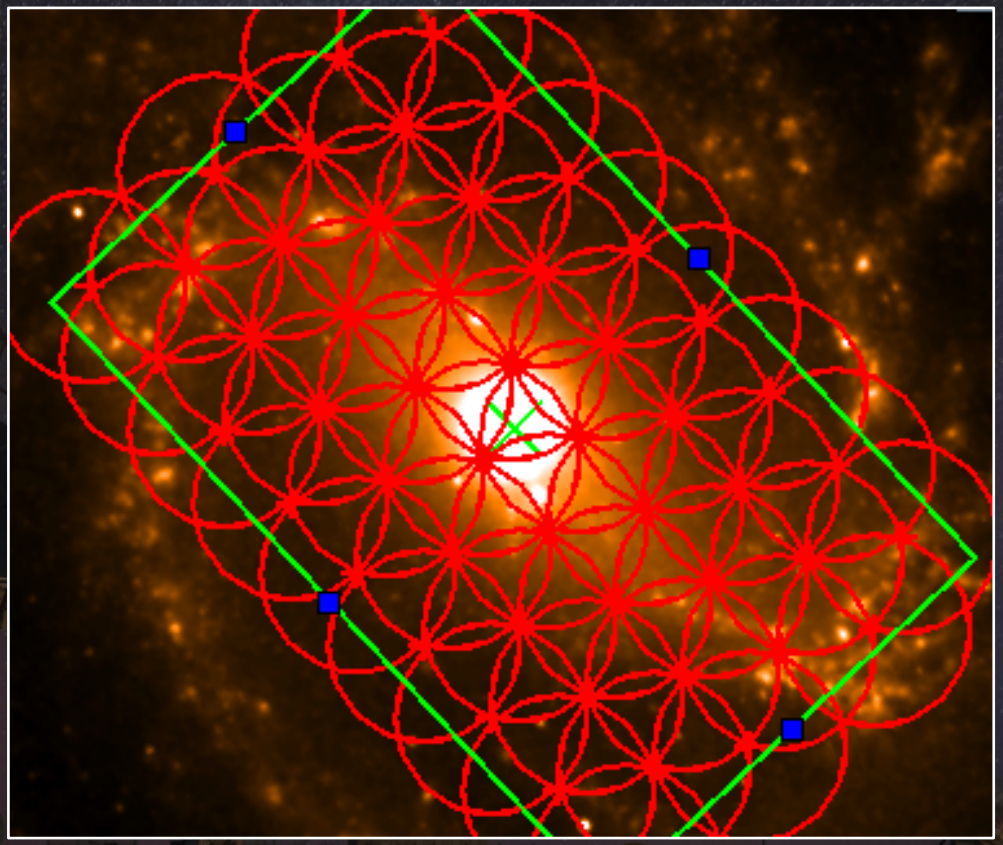
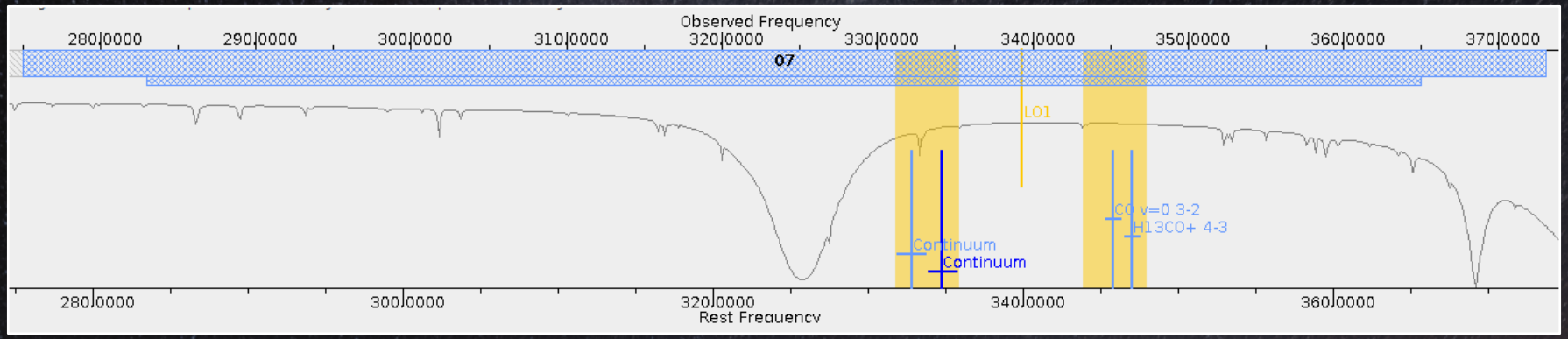


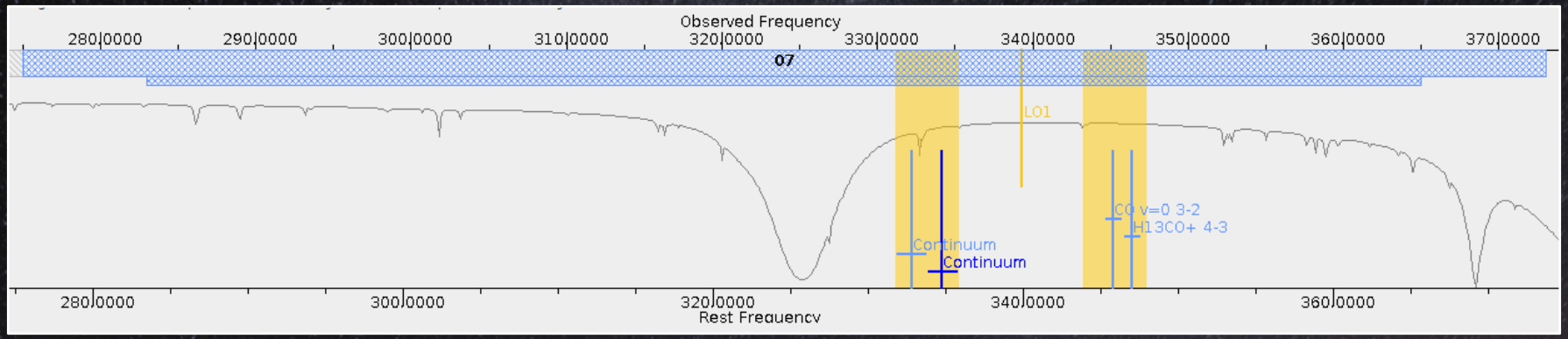


ALMA currently offers three types of spectral set-ups.

- Spectral line imaging mode
- Continuum mode
- Spectral scan mode

In all three modes, each observation is normally performed with 4 spectral windows (spws), with two spws on each side of a local oscillator signal (except for bands 9 and 10, where all the spws are on one side of a local oscillator).

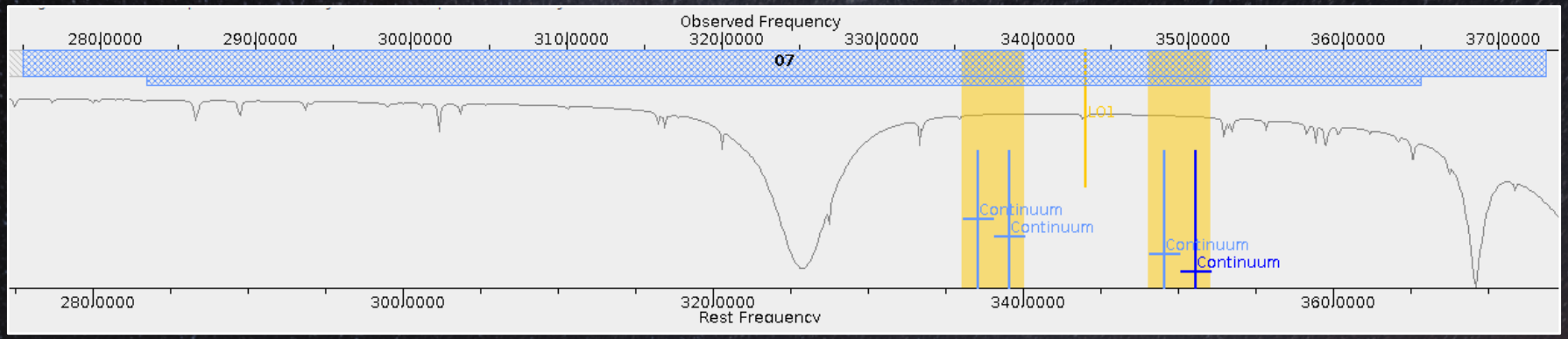
Each spw can contain up to 3840 channels (or 4096 for the ACA). Averaging the channels by a factor of 2 is usually appropriate (because the data are effectively smoothed by the electronics over 2 channels), although observations are often smoothed more than this.



In the spectral line imaging mode, the central frequencies of the spws can be set to the frequencies of specific spectral lines or to arbitrary frequencies.

The spw widths can vary from 59 MHz to 1.875 MHz.

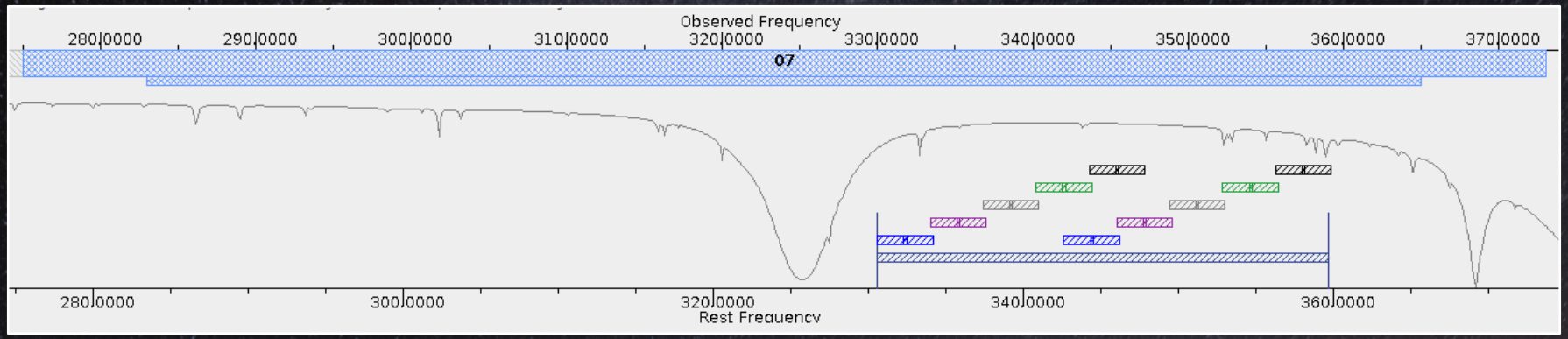
More than 4 spws can be created, although the total number of channels cannot be increased.



In the continuum mode, each spw is set to the widest possible bandwidth (2 GHz) and coarse resolution (128 channels). Nominally, the total part of the spectrum covered is 8 GHz.

In band 9 and 10, the electronics are set up to use a switching technique that will cover 16 GHz of the spectrum.

Default frequency tunings are provided for each ALMA band, but this can be adjusted if needed.

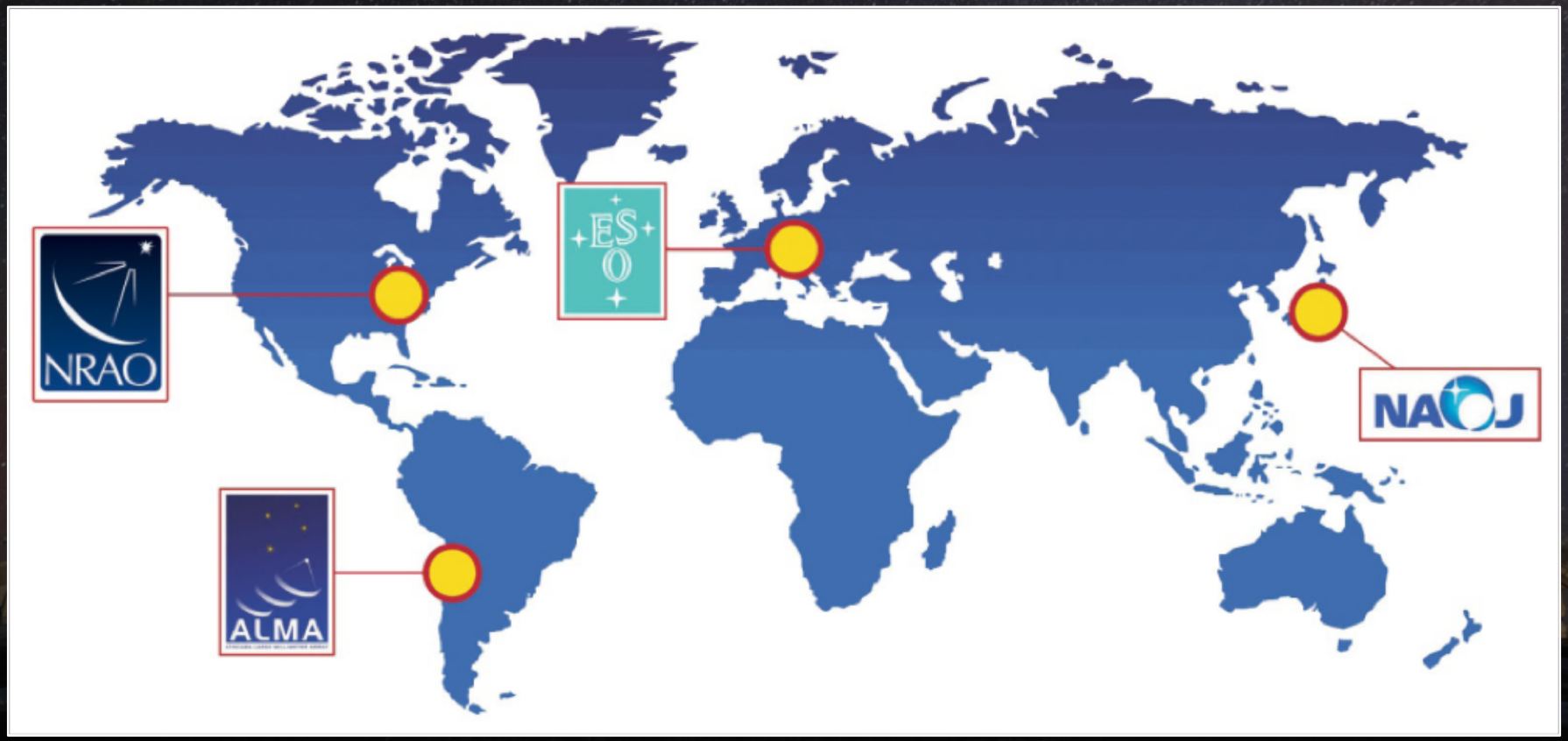


In the spectral scan mode, a series of tunings are used to cover emission over a broad range of frequencies.

The observations are set up using broad spw widths (0.469-1.875 GHz) and 3840 channels per spw.

ALMA is operated by a collaboration between North America, Europe, and East Asia.

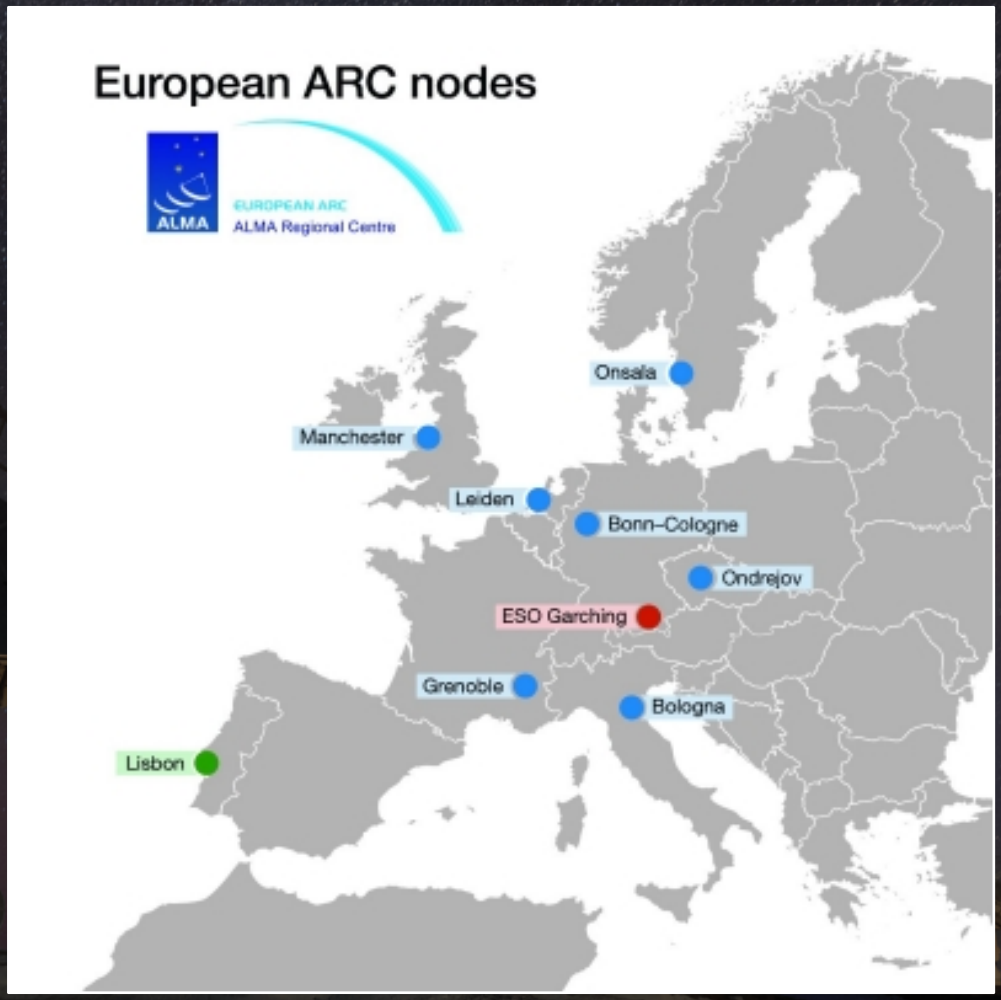
The Joint ALMA Observatory in Chile coordinates all activities.



The European Southern Observatory coordinates ALMA activities in Europe.

Multiple ALMA Regional Centre Nodes provide local user support. Staff at these nodes also participate in other support activities.

The University of Manchester hosts the ARC Node for the United Kingdom.



Cycle 6 capabilities

- 43 main array, 10 ACA, 3 total power antennas operational during observing
- Bands 3-10 operational
- Angular resolutions up to 0.025” possible
- Linear and circular polarization capabilities in bands 3-7
- ACA can be used by itself
- Large programs (up to 50 h) now being performed
- Very long baseline interferometry possible in bands 3 and 6
- Solar observations possible in bands 3 and 6

2019 schedule

February	Shutdown for altiplanic winter
19 March	Call for proposals for Cycle 7
17 April	Proposals due
End of July	Announcement of proposal review process
05 September	Submission of Phase 2 material (prepared observations) for Cycle 7
01 October	Beginning of Cycle 7